CARLISLE
COATINGS & WATERPROOFING

Introduction to Water Resistive Barriers (WRBs) & Air Barriers

Air, Vapor or Water Resistive Barrier?

Even industry experts confuse air, vapor and water resistive barriers. Let's define the terms:

Air Barriers resist air leakage and form a continuous plane around a building to prevent uncontrolled air movement in and out of the building envelope.

Vapor barriers limit the amount of water vapor diffusion through the wall as a result of different vapor pressures. Vapor barriers still have to be continuously sealed, and free of holes.

Water Resistive Barriers keep liquid water from entering the building enclosure. Combined with flashing and other materials, WRBs ensure that there is a completely sealed assembly to direct liquid water to the exterior.

A single material can function as all three, an air, vapor and water resistive barrier. There are also materials that function only as a water resistive barrier that are not air barriers. Understanding the functions of the materials used is critical, so that the building performs in accordance to the design intent. This e-booklet focuses on requirements for WRBs.

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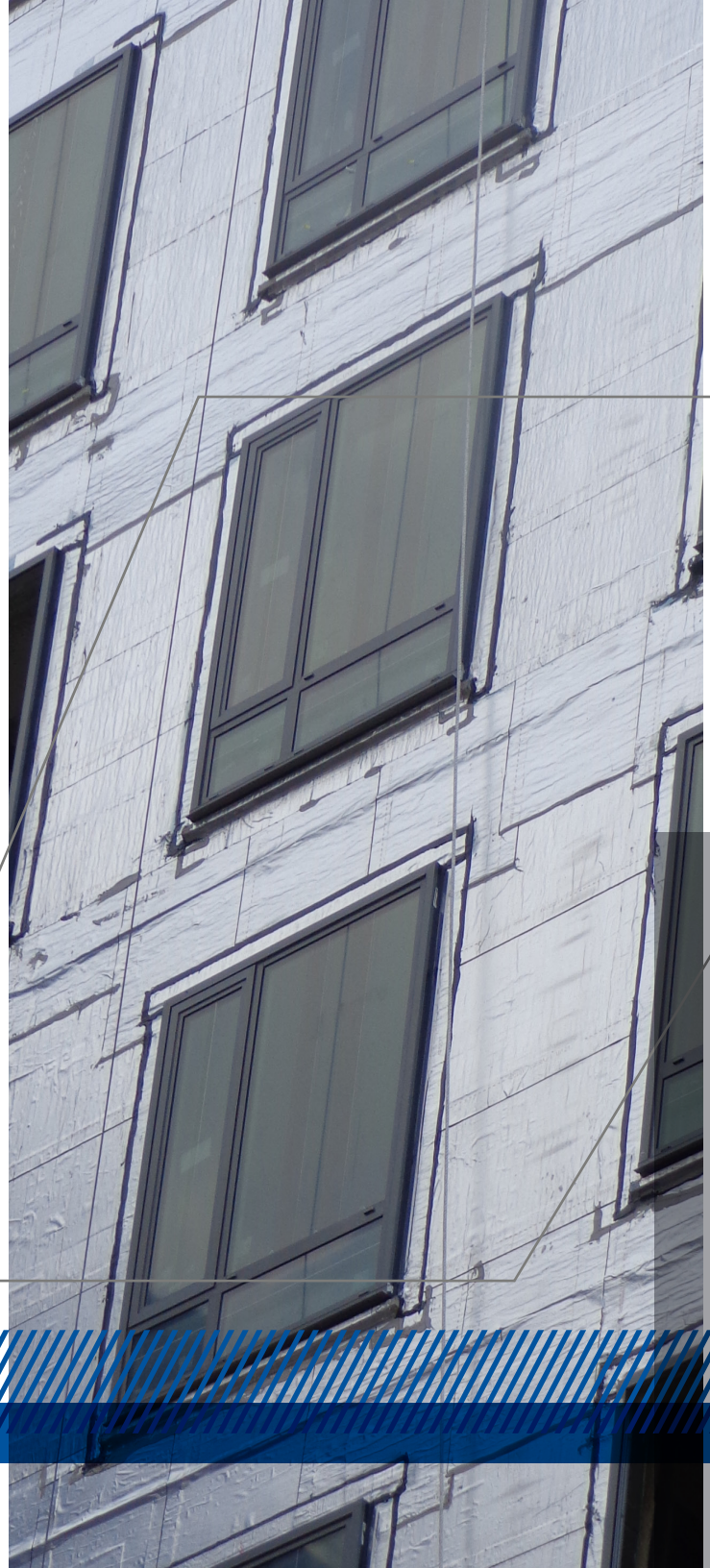

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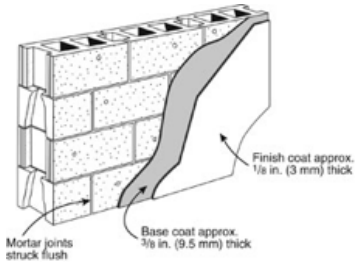
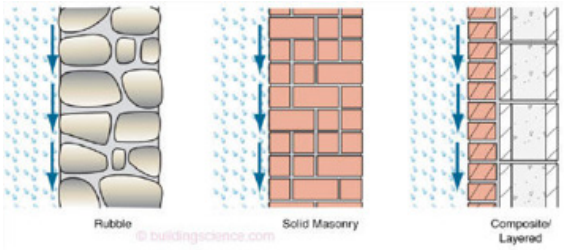


Mass wall sections showing barrier cladding function – water shedding at exterior



Direct-applied stucco over single wythe concrete block wall

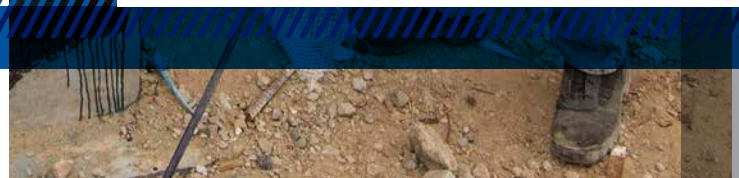
Masonry mass wall – 19th Century

Systems Defined: Barrier cladding, Membrane-drained cladding, Drained and back ventillated cladding

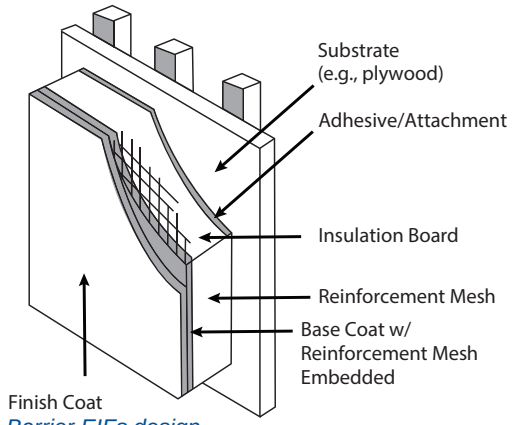
A barrier-wall system should be matched with cladding material that's resistant to water and vapor. Poor cladding can be detrimental to the envelope of a building, so be sure to select a material that is impervious to the elements. Many cladding materials tend to respond differently to environmental factors.

Barrier Cladding Systems

- Mass wall construction – masonry or concrete.
- Rain water is managed on the exterior surface
- Water intrusion past the exterior surface is absorbed and released – wall materials are moisture-tolerant
- Maintenance of the exterior is critical for longevity. Caulking, tuck pointing.
- Old technology. It works, but it's costly, requires skilled tradesmen and cannot be used in taller buildings.



Fluid-applied WRB and air barrier membrane on exterior gypsum sheathing (Barritech VP)



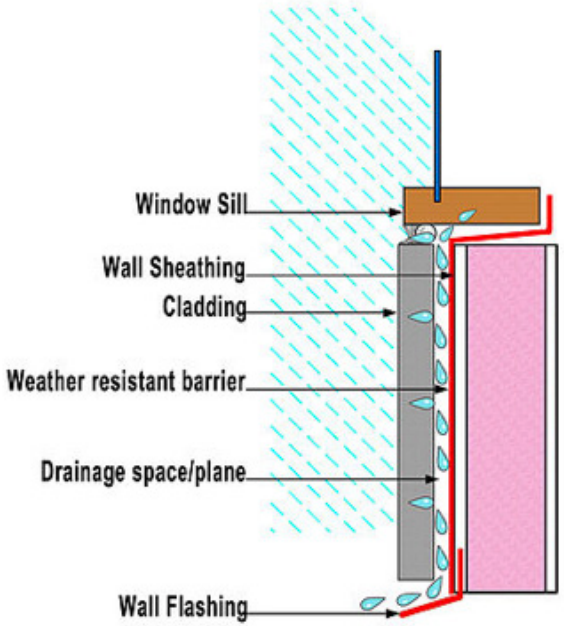
Barrier EIFs design

1980s system

Exterior insulated finish systems (EIFs) gained popularity in the 1980's and but experienced a significant number of serious failures, mostly due to rain penetration. Early EIFS face-sealed systems that by definition had no provision for drainage. Early EIFS facade systems neglected to include any provision for drainage.

Barrier EIFs – A Failed Barrier Cladding System

- An EIFS is reinforced synthetic stucco applied over foam board.
- Designed to manage water at the exterior surface
- Often installed over moisture-sensitive materials like gypsum, OSB, wood studs and steel studs
- Leaks occurred, primarily through window assemblies and window-cladding interface.
- Moisture intruding behind cladding caused significant damage to sheathing, studs, stud cavity insulation and even interior finishes
- To prevent future failures, EIFS systems marketed for sheathing-over-stud walls are now membrane-drained (must have an underlying WRB)



Unlike face-sealed barrier systems, drainable EIFS can be successfully used as an exterior cladding system in most climates and exposures.

Membrane-Drained Cladding

- The primary barrier to rain water is the exterior cladding
- Wall is designed with a drainage space between exterior cladding and next layer
- A secondary system – the water resistive barrier (WRB) is installed
- Leaks occurred, primarily through window assemblies and window-cladding interface.
- The WRB prevents exterior water, which breaches the cladding, from further intruding into the assembly
- Water is drained on WRB plane and diverted out through flashing and weeps

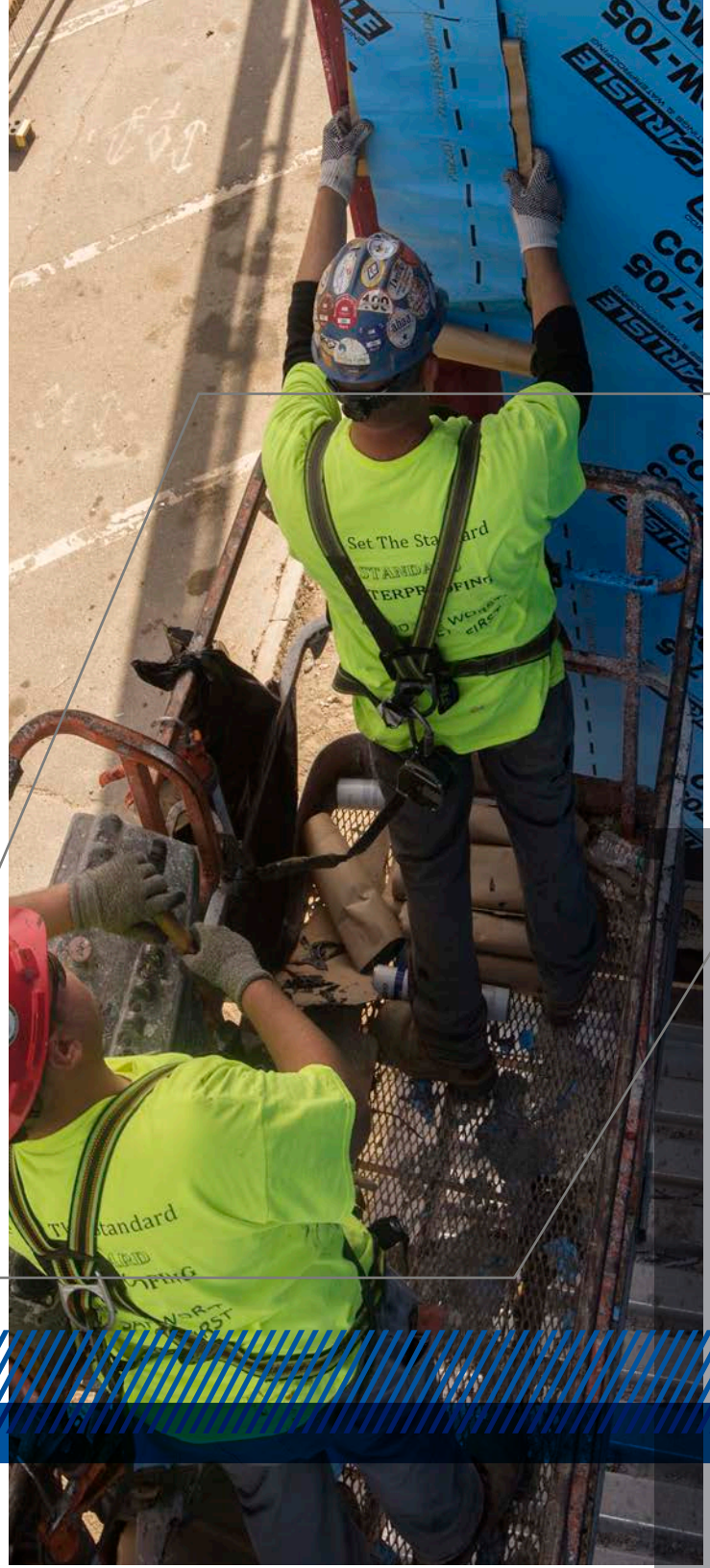
A drained and black ventilated terra cotta cladding system

Drained and Back-Ventilated Cladding

- Called “Vented Cladding” in Building Code.
- Improved moisture management versus membrane drained cladding
- Cladding has open joints or vents. Intentionally leaky to air (and water)
- An air space (typically 3/8” to 2”) is provided between cladding and next layer (exterior insulation or WRB)
- Cladding has weeps and ventilation
  - — Allows ready drainage of water
  - — Allows free circulation of air to facilitate drying of cladding, exterior insulation,attachment hardware and WRB
- WRB system must be water tight AND air tight
- Also called a “rain screen” cladding

Another Benefit:

Per IBC 2009, 2012 and 2015, increased drying potential provided by vented cladding negates the requirement for vapor retarder installation in Climate Zones Marine 4, 5 and 6.



CLADDING EXAMPLES

Membrane Drained EIFS system:

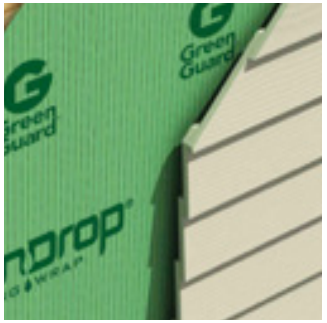
CCW-705 over exterior sheathing, self-furring metal lath, EPS insulation board, synthetic stucco

Membrane Drained Masonry Veneer:

Barritech VP over exterior sheathing, 1-2” air space

Drained and Back-Ventilated Composite Panel Cladding:

Self-adhered VP sheet over exterior sheathing, mineral fiber insulation, girt attachment hardware to maintain air space



Membrane Drained Siding –

Textured building wrap over OSB sheathing.

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Grade D Paper (EIFS Equivalent) mechanically-attached over exterior sheathing.

Roll of No. 15 Felt (formerly 15# Felt)

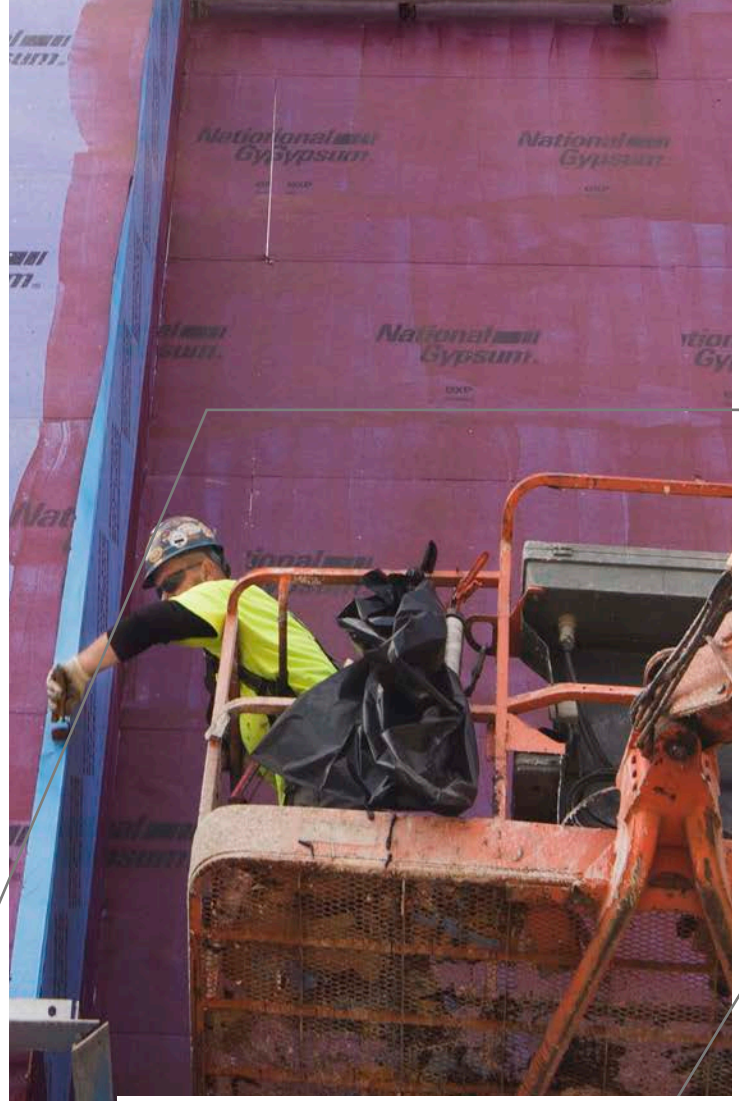
What is the function of a Water Resistive Barrier?

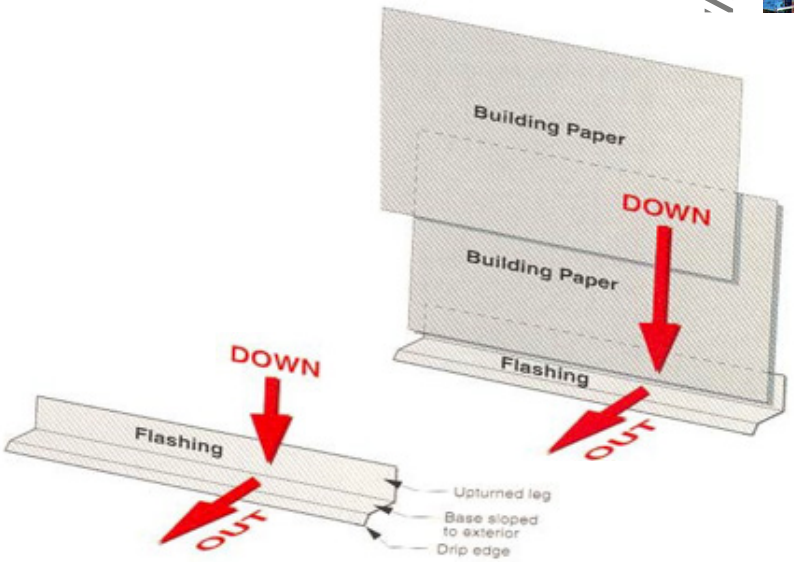
The design and construction of the exterior wall must include a water-resistive barrier behind the exterior veneer that prevents the accumulation of moisture within the wall assembly. The exterior wall must also include a way for water/condensation that enters the wall assembly to drain/evaporate.

Building Code WRB Requirements

- Minimum 1 layer of WRB is required to be installed over exterior sheathing or on the exterior side of studs.
- WRB needs to be EIFS Felt meeting ASTM D 226, or other approved material
- Approved material is demonstrated to perform as well or better than EIFS felt as a WRB.
- WRB also has to be integrated properly with flashings in building details.
- Stucco claddings require 2 layers of WRB
- WRB is not required over concrete block or concrete walls

*** REF: Chapter 14 of International Building Code (IBC) 2006, 2009, 2012 and 2015*



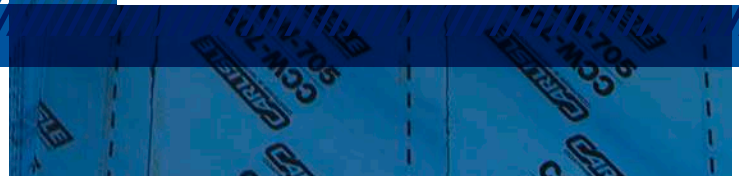


Types of materials marketed as WRBs

Referred to in the building code as a “water-resistive barrier,” the main goal is to keep liquid water out of the structural part of a building. At the same time, the WRB must allow water vapor to pass through so the framing and sheathing can dry to the exterior if it gets wet.

Choosing a Water Resistive Barrier

- Paper or Felt Type
- Polymeric Type
- Mechanically-attached to the exterior side of stud walls – Stapes, nails, capped screws, battens
- Neighboring sheets are lapped
- Lap onto flashings
- Laps may be taped or caulked



Grade D paper with stucco lath

Paper or Felt Type WRBs

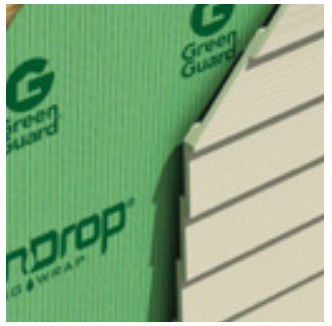
- 15# Felt
  - — Historic: Cotton fiber felt saturated with coal tar pitch or pine tar Weighed 15 lb per 100 SQ FT.
  - — Current: Called “No. 15” felt, promoted mostly for roofing underlayment.Organic felt made from recycled paper and/or fabric, saturated with asphalt or coal tar. No longer weighs 15 lb per 100 SQ FT.
  - — Specification: ASTM D 226 or D 227
- Grade D Paper Asphalt-saturated Kraft paper
  - — Specification: ASTM D 226 or D 227Resists water for 10 min to 60 min
  - — Specification: ASTM D 226 or D 227Specification: “Code Approved” (ICC-ES AC-38 or UUB 790a)
- Materials are Vapor Permeable
- Materials are NOT Air Barriers

BARRIER TYPES

Building wrap on a commercial building

Building wrap on a commercial building

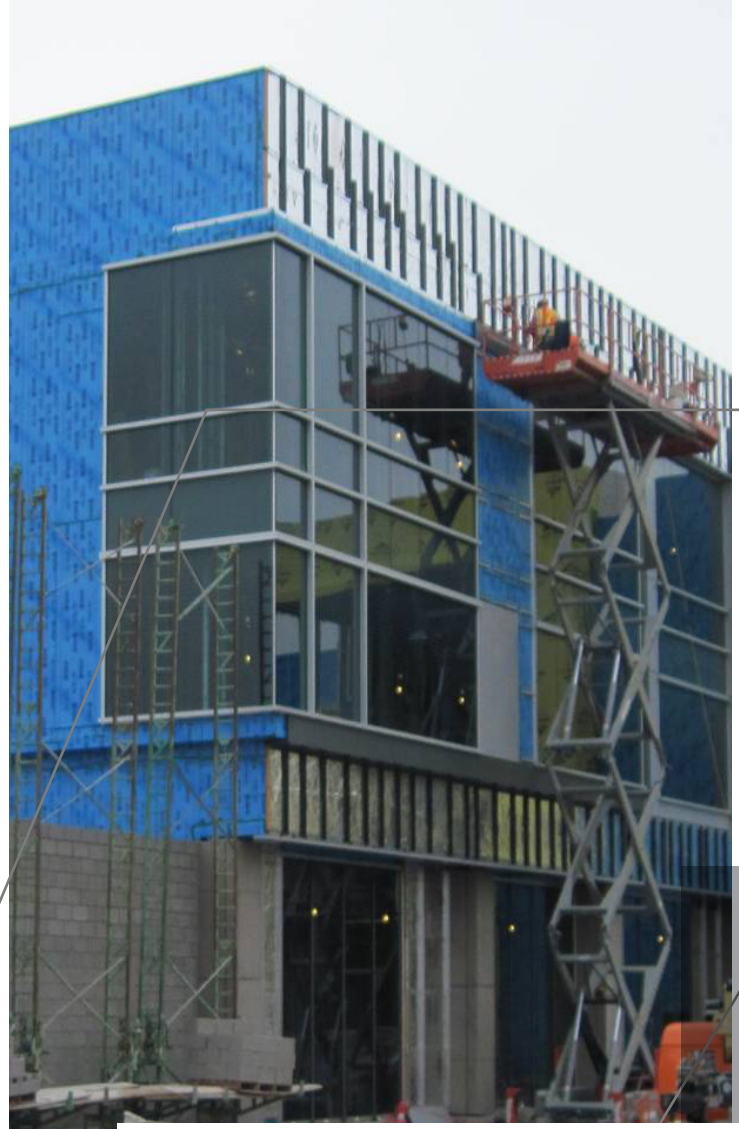
Building wrap installation on a home



Building wrap installation on a home

Building Wraps

- Spun Bonded Polyolefin (non-perorated)
  - Tyvek
  - Typar
  - Woven or Perforated Polyolefin
    - NovaWrap
    - Green Guard
  - Engineered Fabric
    - Vaproshield
    - Cosella-Dorkin

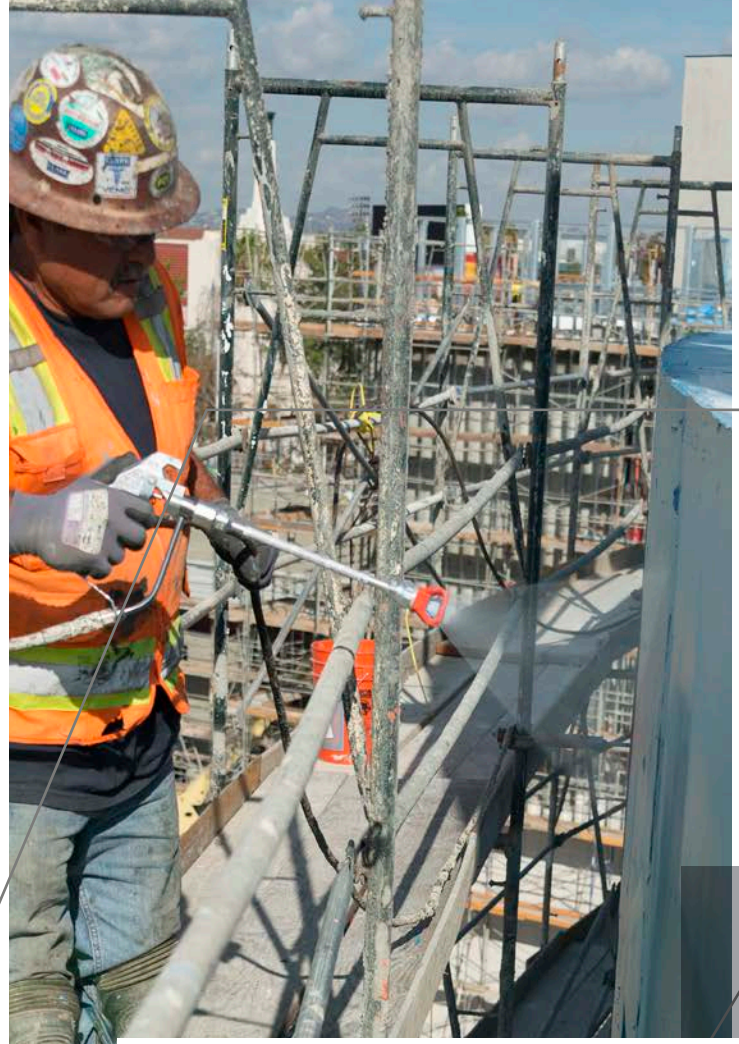


ADVANTAGES

A number of materials, including traditional asphalt felt (tar paper) have this ability to stop liquid water while remaining “permeable” to water vapor.

Building Paper, Wrap and Felt Advantages

- Lighter weight, more flexible than paper or felt WRBs
- Installs over sheathing (Spec: ICC-ES AC 38)
- Materials are vapor permeable
- Conventional, Well-Known
- Can be installed by unskilled labor
- All-Season Installation (adhesion to substrate not required)Long Track Record (Some Products)
- Relatively Low Cost



LIMITATIONS

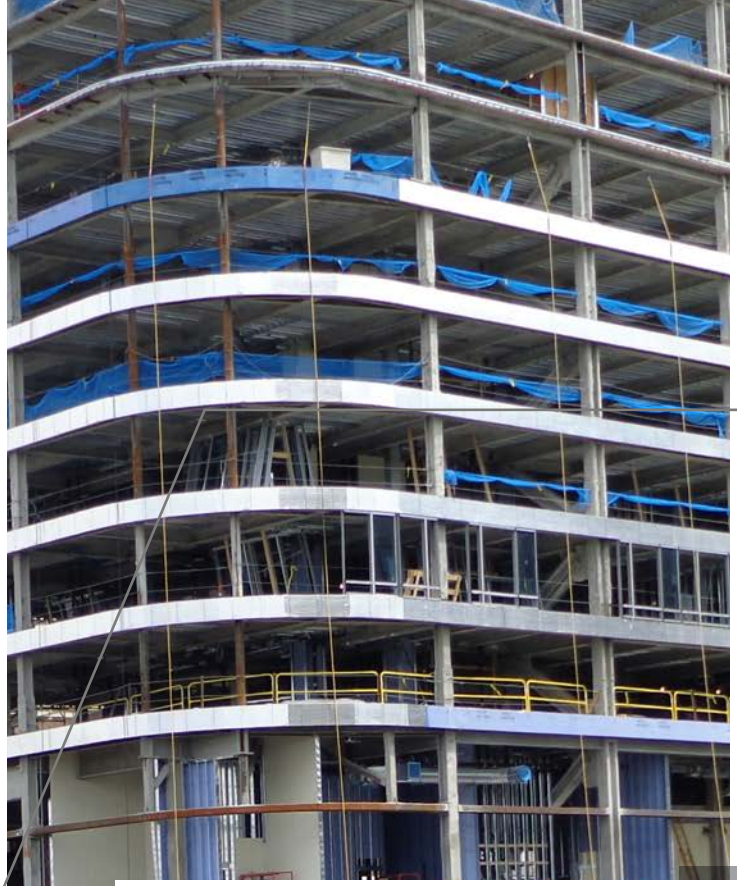
Building wrap fluttering loose from substrate on commercial project

Failure of Grade D paper – reverse lap at window sill flashing

Common mistake – reverse lap of window head flashing and building wrap

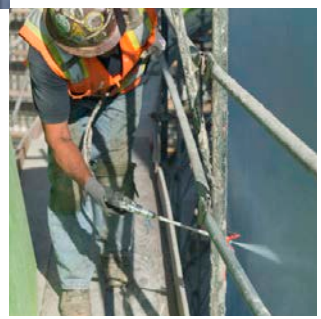
Building Paper, Wrap and Felt Limitations

- Not fully adhered to substrate – water and air can travel between WRB and substrate
- Proper lapping with adjacent flashings is critical
- Often tears, rips and comes loose during exposure
- Can be damaged or destroyed by contact with :
  – Residue from wood products, detergents
  – Stucco and Mortar
- Not effective air barriers
  – Fluttering away from substrate
  – Leaky terminations and penetration



Are WRBs and Building Wraps Air Barriers?

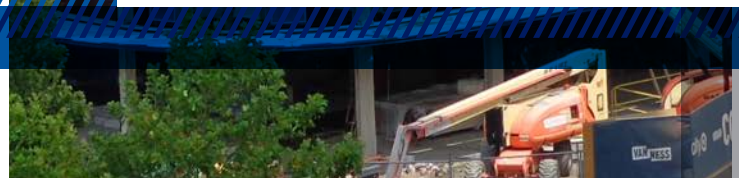
Fluid-applied WRB and air barrier membrane on exterior gypsum sheathing (Barritech VP)



Self-adhered sheet WRB and air barrier membrane on exterior gypsum sheathing (CCW-705)

WRBs as Air Barriers

- The WRB location (exterior side of wall) is also an ideal location for the air barrier
- On the exterior side of the wall, achieving continuity of the air barrier is most practical
  – Wall to window/door frames
  – Inter-story continuity
  – Roof-wall tie-in
  – Wall-foundation tie-in
  – Transition to dissimilar wall assemblie
- Strategy – Use a WRB material that is also airtight
  – “Beefed up” building wrap with sealed laps, penetrations and terminations + enhanced fastening
  – Fully-adhered membrane on rigid substrate
- Fluid-Applied
- Self-Adhered
- Closed Cell Spray Foam
  – Sheathing boards with factory-applied WRB and field-sealed joints, penetrations & terminations
- Closed cell foam rigid board: EPS with facers, XPS, Foil-faced Polyiso
- Gyp sheathing with factory-applied WRB



What is an Air Barrier?

Air barriers are critical to achieving building energy efficiency and indoor environmental quality, as well as satisfying code requirements. It's important to remember, an air barrier is not a single product, but rather a system of products that produce an air barrier assembly.

Air Barrier Requirements

- Materials must be impermeable to air
- Withstand combined wind, stack and fan pressures
- Accommodate differential movements, including dissimilar materials & assemblies, control, expansion and seismic joints
- Be durable or maintainable
- All penetrations made through the air barrier shall be sealed
- Continuous installation over whole building enclosure--air barrier on exterior walls with durable tie-in to:
  - Windows & doors
  - Wall-to foundation
  - Wall-to-roof
  - Flashings at openings, terminations and transitions
  - Termination at existing construction
  - Transition to neighboring assemblies, examples: deck, balcony, canopy, dissimilar wall assemblies

REF: 2012 & 2015 IECC, 2010 & 2013 ASHRAE 90.1
This requirement is so important that model energy codes (IECC and ASHRAE 90.1) reference the system as the "Continuous Air Barrier"

Tyvek Commercial Wrap ASTM E 2357 (Air Barrier Assembly) Mockup. Taped laps, close spacing capped screw fastening. Flashing tape at all penetrations. Product is not typically installed this way.

Taped building wrap installation in progress on a commercial building

Building Wraps as Air Barriers

Although building wraps are marketed as air barrier materials, their primary function is to act as a water-resistive barrier (WRB). Building wraps can be an air barrier, but careful attention must be placed on keeping the assembly airtight around seams, transitions and window openings. Most building wraps are best used to protect the wall sheathing from any wind-driven rain that gets past the cladding.

Disadvantages

- Most are not air barriers
- Sheet materials are permeable to air
- Even with air barrier building wraps, it is challenging to effectively install them as a continuous air barrier in commercial construction

Foil-faced PIR with taped joints (R2+ SHEATHE & FG-1402 Tape)

Self-adhered sheet membrane

Fluid-applied membrane (Barritech VP)

Commercial Building WRBs which are also Effective Air Barriers

- Specialty sheathing boards with sealed joints, terminations and penetrations
  – Rigid foam board: XPS, Faced EPS or foil-faced PIR
  – Gypsum sheathing with factory-applied membraneClosed cell spray polyurethane foam: exterior application with detail flashings
- Self-adhered sheet membranes
- Fluid-applied membranes

WRB gyp sheathing with caulked joints. GP DensElement with Prosoco Fast Flash

Foil-faced polyiso board with taped joints. R2+ SHEATHE with FG-1402 tape

“Boards and Tape” Systems

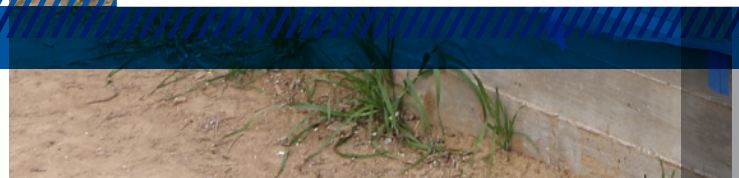
- Application on exterior stud walls.
- Spec for board insulation WRBs is ICC-ES AC 71
- Spec for flashing tape on boards is AC 148
- Spec for caulking or liquid flashing on boards is AC 212
- Spec for factory-applied WRB to sheathing is AC 310
- Boards are fastened to studs. Joints, penetrations and terminations are sealed with flashing tape or liquid material
- Insulation board products are also continuous insulation (CI).

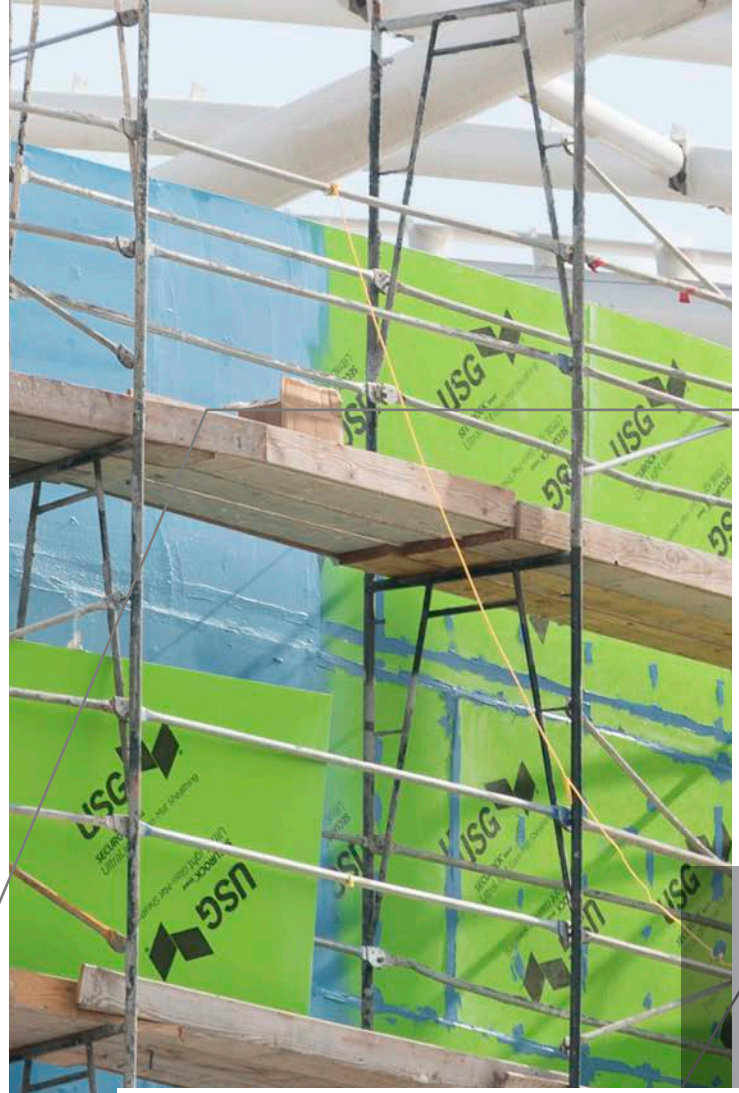
Completed installation, brick veneer being installed over spray foam WRB

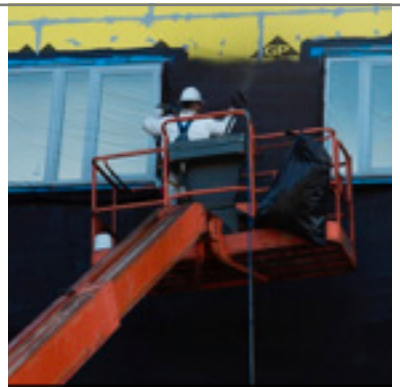
Spray installation in progress

Spray Foam Systems

- Specs are ICC-ES AC 377 and ICC-ES AC-71
- Installed on the exterior side of the wall (not between the studs)
- Medium density closed cell foam and flashing membrane or liquid flashing details
- Fully-adhered to the substrate
- Non-permeable system
- Is also continuous insulation (CI)





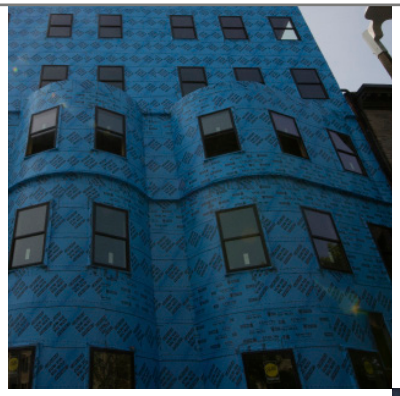


Barriseal (non-permeable, asphalt-emulsion based) with caulked board joints

Barritech VP (permeable, latex-based) with DCH Reinforcing Fabric over board joints

Fluid-Applied Membrane Systems

- Application on exterior sheathing. Spec is ICC-ES AC 212
- Can be Vapor-Permeable or Non-Permeable
- Products range from 7 to 125 mils dry film thickness
- Varying chemistries: asphalt emulsion, latex, synthetic rubber, silicone, silane-terminated polymer (STP)
- Spray, roller or trowel applied
- Fully-adhered to substrate
- Reinforcement or caulking required in board joints



CCW-705 (non-permeable) on a commercial building

705 VP (permeable) on a commercial building

Fluid-Applied Membrane Systems

- Application on exterior sheathing. Specs are ICC-ES AC 38 and ICC-ES AC 148
- Can be Vapor-Permeable or Non-Permeable
- VP sheet product is 20 to 25 mils thickness, non-permeable product is 40- mils thick
- Non-permeable product is also water proof

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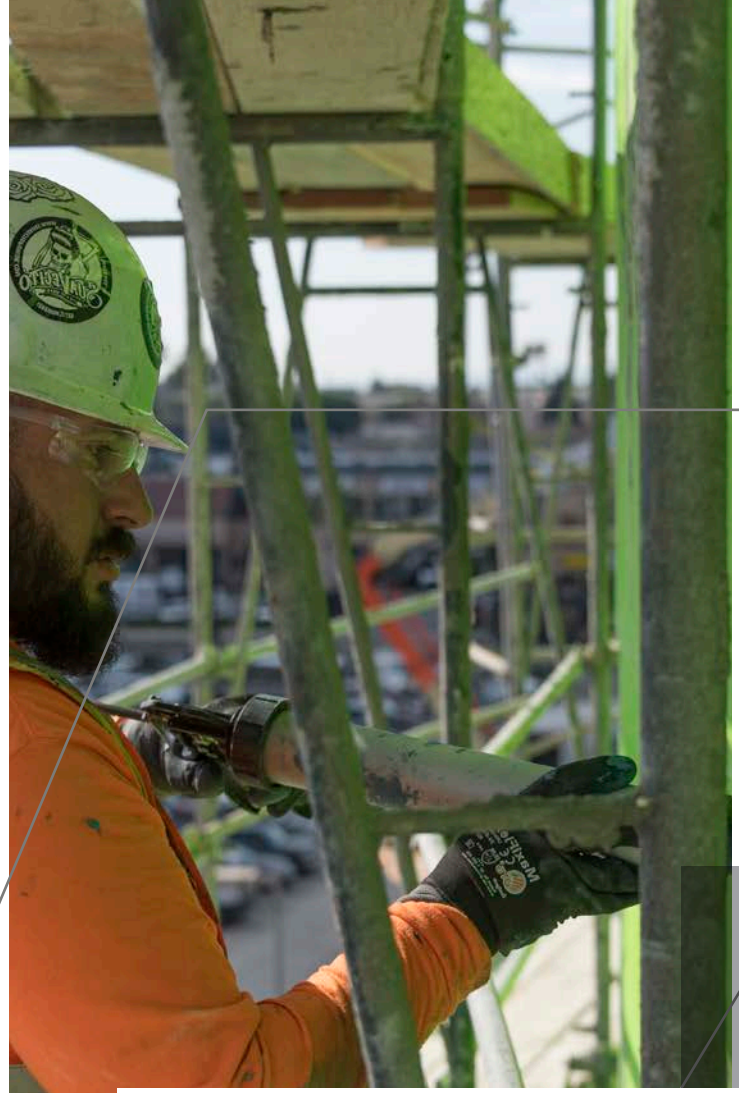
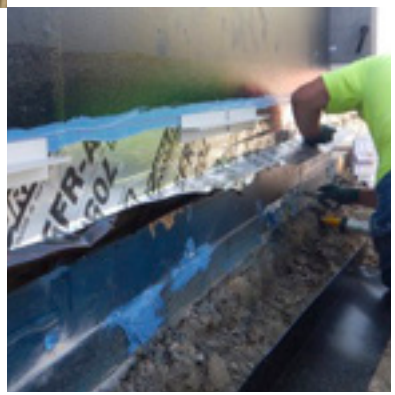
Critical for performance of the WRB system! Flashing as specified in Building Code

- Installed to prevent water from entering, or to re-direct water to the exterior
- Perimeters of exterior window and door assemblies
- Exterior wall Penetrations and Terminations
- Exterior wall intersections with roofs, chimneys, porches, decks, balconies and similar projections
- Flashing with drip edge required on both sides of roof coping, under sills and continuously above projecting trim
- In masonry veneer – through-wall flashing required anywhere there is an interruption in the cavity – window head, window sill, relieving angle, base of wall, roof line



Proper shingle lap of felt WRB onto base of wall flashing



Barritech NP. 705 FR-A & Barribond-Flashing detail installed over fluid-applied WRB. Reverse lap is sealed with caulking. This is OK, because all components are fully-adhered.

Fully-Adhered Membrane WRBs Have a More Robust Tie-in to Flashing Details

- Self-adhered flashing must go on solid substrate, not over mechanically-attached sheet WRBs! Otherwise, any breach in the WRB would completely undermine the flashing
- Self-adhered flashing can go over or under fully-adhered WRBs!

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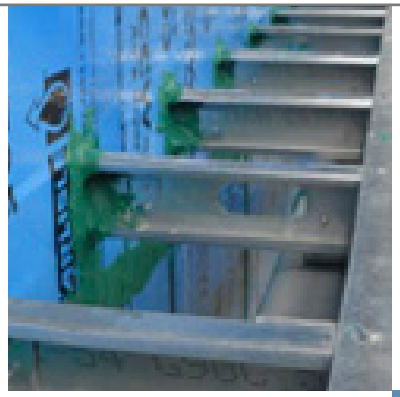

Liquid air/vapor barrier & WRB membrane enhances air & water tightness of concrete block wall

More Advantages of Fully-Adhered Air Barrier WRBs

- Self-adhered flashing must go on solid substrate, not over mechanically-attached sheet WRBs! Otherwise, any breach in the WRB would completely undermine the flashing
- Self-adhered flashing can go over or under fully-adhered WRBs!

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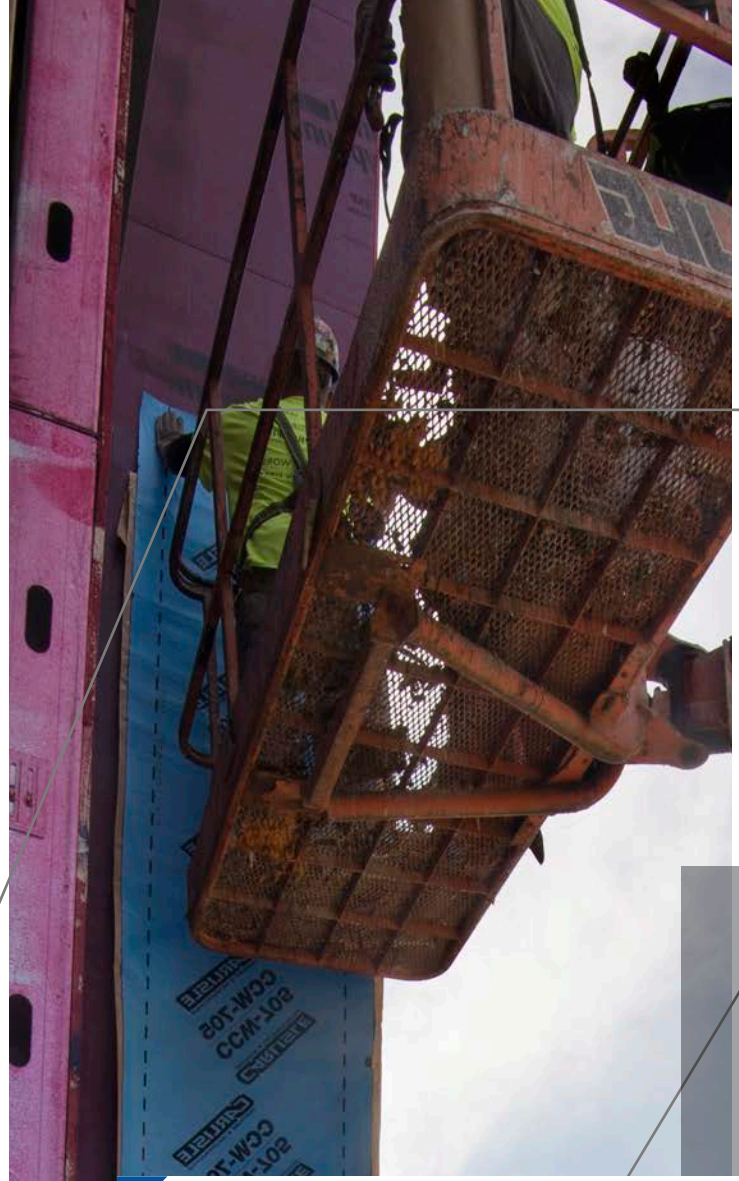

DETAILS

Self-adhered sheet membrane

Wrapped openings ready to receive window and perimeter caulk

Continuity is Essential to wall foundations

- Adhere TWF to fully-adhered sheet membrane WRB – note proper lap and termination.
- Lap fully-adhered sheet membrane WRB over below-grade waterproofing

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JOINTS

Bulb joint

Bellows joint

Continuity is Essential for drift joints

- Standard detail in fluid-applied and sheet-applied systems
- Accommodate movement while maintaining air and water tightness

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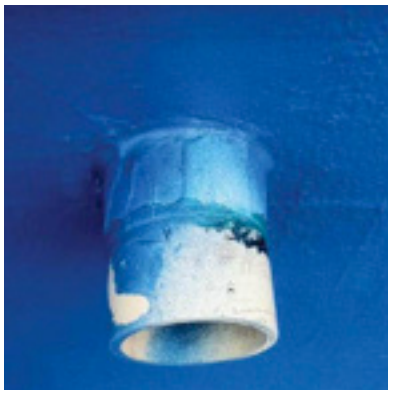
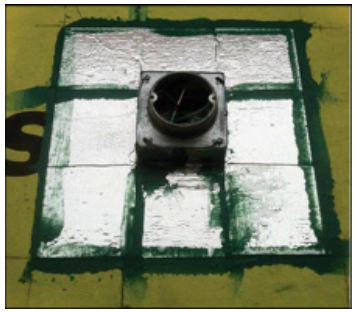
PENETRATIONS

I beam penetration





HVAC penetration

Continuity – Pipe, Duct & Beam Penetrations

- Standard detail in fluid-applied and self-adhered sheet systems
- Membrane is wrapped onto penetration when possible

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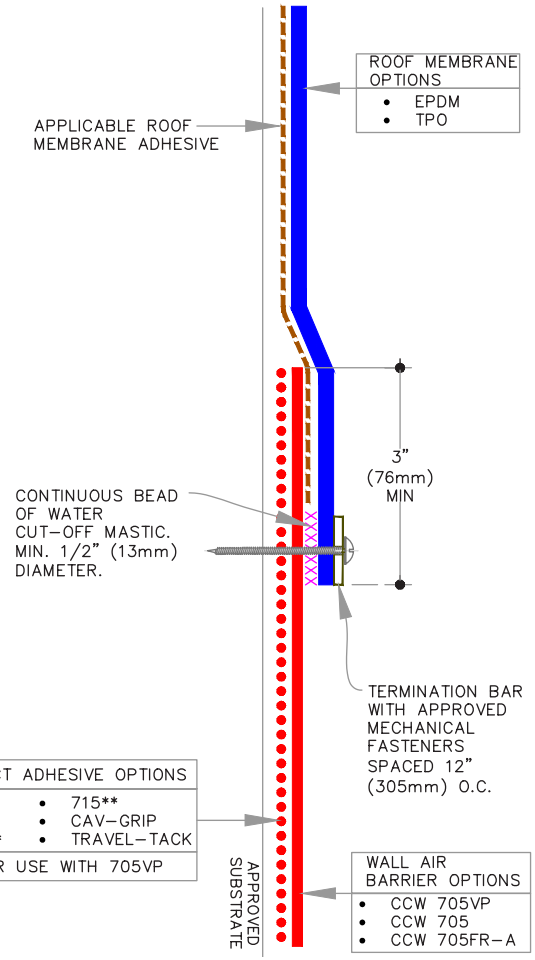
TIE-INS



Tie-In to Single-Ply Roof at Parapet

- Lap of fully-adhered wall membrane and fully-adhered roof membrane

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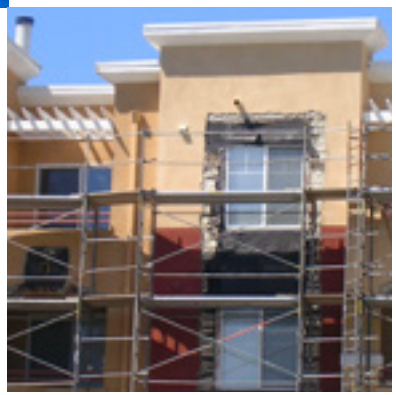
PERFORMANCE

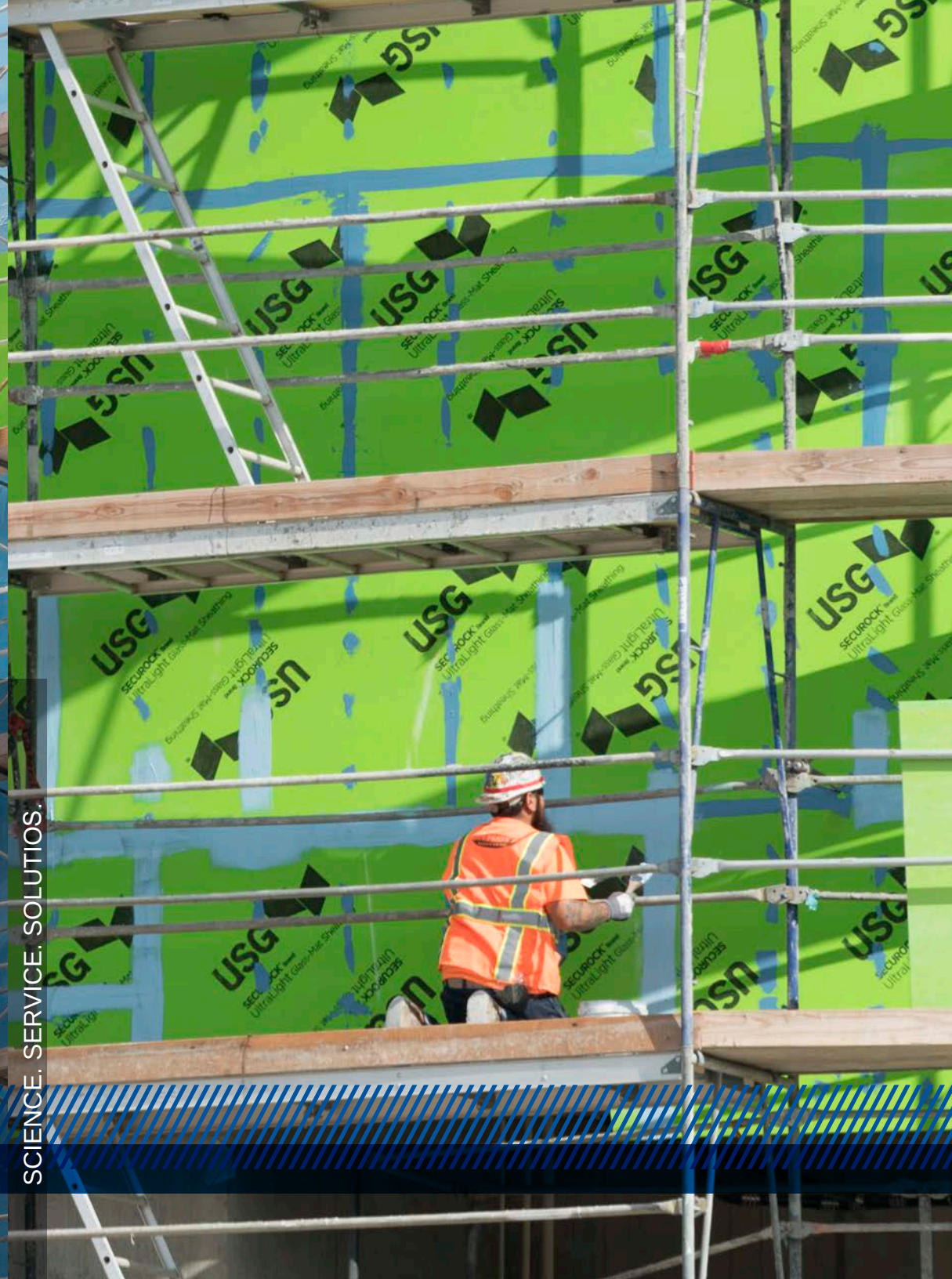
Repair and replacement of through-wall flashing (TWF) at window head. Cost to install TWF in new construction: $4-5 per lineal foot. Cost to re-do: $150-$200 per LF



Repair and replacement of window flashings. Requires scaffolding and removal of cladding

WRB and Flashing Details are critical to building performance.

- Failed WRB or flashing detail can cause damaging leaks
- Repair often requires removal of the cladding and repair/replacement of WRB and flashings.



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